Assessing the risk an individual patient presents in the perioperative period is a daily task for anaesthetists and surgeons. A considerable research effort has been directed at this problem over many years with the aim of identifying the ‘at risk’ patient at an early stage. The purpose of this is to allow time to improve any elements of the patient’s condition that are amenable to treatment (optimization) and, of equal importance, it allows informed decisions to be made on the best course of treatment and techniques to be used in the patient’s management. Are we now in a position where we can accurately determine an individual patient’s level of risk?

Much of the early work on perioperative risk, during the 1970s and 1980s, was directed at reducing the incidence of perioperative myocardial infarction (PMI) which was said to carry a 70% mortality rate, perhaps as a result of prolonged unidentified (silent) ischaemia. At this time, recent myocardial infarction was identified as a major factor and the incidence of PMI was shown to decrease from around 25%, if the patient underwent an operation within 3 months of an infarct, down to a stable level of around 5% after 1 yr.

In clinical practice, we make our assessment of a patient’s cardiac status based on the time-honoured approach of history, examination, and investigations. This can establish the presence of known risk factors such as previous myocardial infarction (MI), hypertension, heart failure, arrhythmia, and diabetes mellitus. This approach was the basis of the scoring indices devised by Goldman and colleagues and Deticky and colleagues which allot risk points based on history (e.g. previous MI), examination (arrhythmia), and investigations (abnormal electrolytes). The application of systems such as these was a step in the right direction in that it helped to identify potential problems at an early stage. However, their limitation is that they can only place a patient within a band of risk rather than provide a specific measure of an individual’s level of risk.

The next step in this was to explore methods of assessing myocardial function. This included the use of 12-lead ECG, ambulatory and exercise ECG, echocardiography (static and stress), ventriculography, radio-isotope scanning, and coronary angiography. During the late 1980s and early 1990s, the utility of all of these methods was investigated in ‘at risk’ populations, often vascular surgery patients. These studies found a scatter of results with some showing a reasonably high correlation between preoperative findings and postoperative events, but others using the same investigation finding a poor predictive relationship. Even some of the studies using more invasive investigations such as dipyridamole-thallium scintigraphy (DTS) could only place patients in risk categories rather than specify a risk. For example, seven of 15 patients with demonstrable defects on DTS had postoperative ischaemic events and none of those with no demonstrable defect had a postoperative event. Although this is reassuring for those with no defect, we are left with an at risk group with a 50:50 chance of developing a postoperative complication. The cumulated evidence from all these studies was synthesized into guidelines produced jointly by the American College of Cardiology and the American Heart Association in 1996 and subsequently updated. This proposed the use of clinical predictors to classify patients as low, intermediate, or high risk. An example of each would be poorly controlled hypertension, previous MI, and unstable angina, respectively. On the basis of this classification, the patient is entered into one of the three algorithms which determine the appropriate investigations of cardiac function. Two important factors are emphasized in the management. First, that the anticipated surgical intervention is graded as well. This is an important concept in that it is clear that in some patients, the option of a less invasive surgical procedure is the correct one. The second factor introduced is quantifying the exercise tolerance of the patient as part of the algorithm. This, indeed, goes back to our history taking but provides a framework to build it into the management. The unit used in the ACC/AHA guidelines is the metabolic equivalent (MET) with 4 METs equating to the ability to walk up one flight of stairs.
The concept of using METs provides a link to more recent work which has focused on more specific measurement of patients’ cardiorespiratory reserve. This is a logical progression, in that the critical balance is the matching of oxygen supply with oxygen demand. Although there are some patients whose risk will be entirely dependent on one element, for example, end-stage cardiac or respiratory failure, many ‘at risk’ patients will have an inter-dependent action from both cardiac and respiratory disease processes. A good example here would be the long-term smoker who has both ischaemic heart disease and chronic bronchitis. It is therefore logical to attempt assessment of the exercise capability of a patient as a measure of the cardiorespiratory reserve. The limitation of a patient’s exercise ability will be when they have to stop because of breathlessness or angina. Both of these represent a failure of the supply:demand balance through different mechanisms. The cardiac element of exercise has been addressed through the use of exercise and ambulatory ECG recording. However, these have not been shown to be of particularly good predictive value in a general, elderly population. Likewise, standard respiratory function tests have some value in highlighting a specific clinical problem but do not correlate well with predicting perioperative problems.

Some measure of a patient’s exercise tolerance can, of course, be gained from careful history taking. However, this may not be accurate. Attempts have been made to get round this by the use of a structured questionnaire, such as the Duke Activity Status Index, which grades exercise ability using a series of questions based on the exercise equivalences of daily or regular activity. These range from the ability to wash and dress without breathlessness through to strenuous activity such as singles tennis. The next level from this is to observe the patient exercising in a regulated manner to provide a quantified measure of their tolerance. A simple method, the shuttle test, has been described. This involves the patient walking back and forth between two fixed points, usually 10 m apart, against a timed beep which gets shorter as the exercise progresses. The distance, in metres, completed when the patient has to stop or fails to complete a circuit within the allotted time is used as a measure of exercise ability. This technique has been shown to have reasonable accuracy in identifying ‘at risk’ patients undergoing major surgery such as pneumonectomy or oesophagogastrectomy, where thresholds of <400 and <360 m, respectively, were shown to be associated with increased risk of postoperative problems and mortality. However, patients with physical disability or pain may not be able to do this test. To introduce some measure of the respiratory component, it has been shown that a decrease in oxygen saturation of >4% during a standardized exercise test was associated with a poor outcome after pneumonectomy. The attraction of measuring both the cardiac and the respiratory elements of exercise has led to the introduction of cardiopulmonary exercise testing (CPET). This involves the patient after a programmed exercise routine on a cycle ergometer while inspired and expired gases are measured through a face mask or mouthpiece. This test provides a considerable amount of data on oxygen uptake and utilization and is regarded by many as the gold standard for preoperative exercise testing. The most commonly used data from this test are the peak oxygen consumption (VO2 peak) and the anaerobic threshold (AT) where metabolic demands outstrip oxygen delivery and anaerobic metabolism occurs. The thresholds for classifying patients as lower risk are usually taken as VO2 peak >15 ml O2 kg\(^{-1}\) min\(^{-1}\) and AT >11 ml O2 kg\(^{-1}\) min\(^{-1}\). These thresholds roughly equate to being able to climb two flights of stairs [20×15 cm (6 in) steps per flight] or walk 600 m on the flat.

A study in this month’s *British Journal of Anaesthesiology* has investigated the equivalence of the three tests mentioned above, the Duke’s score, shuttle testing, and CPET, as a preoperative measure of risk in a group of patients with known cardiovascular disease. The patients were classed as either higher or lower risk on the basis of each test. The authors found reasonable correlation between the tests, but conclude that the two simpler tests do not provide as robust information as the CPET. The study did not attempt to relate the preoperative findings to outcome so any conclusions drawn from this study must be qualified. There is, naturally, the tendency to feel that because a test produces more detailed information, it must be of more use. However, this is not necessarily the case. As suggested in a recent editorial in the *British Journal of Anaesthesiology*, we can obtain a vast amount of haemodynamic data from a patient in the perioperative period which, in general, is poorly utilized in relation to outcome. The simple example of perioperative heart rate was given. A further consideration here must also be the availability of CPET testing, which is at present not available in all centres.

So have these advances over the past 20 yr made predicting risk in an individual any easier or more accurate? Overall, it would appear that the options for accurate testing before operation have improved. The accuracy of assigning a patient to higher or lower risk has probably improved and this is important as it informs the crucial decisions about the appropriateness of the proposed surgical procedure. However, we are not yet near the situation where we can give a specific risk value for an individual and this must be the subject of future research. The ideal will be a set of quick non-invasive tests which are widely available and which produce an accurate algorithm which correlates well with overall outcome.

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